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Competing climate feedbacks of ice sheet freshwater discharge in a warming world

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Earth's polar ice sheets are projected to undergo significant retreat in the coming centuries if anthropogenic warming were to continue unabated, injecting freshwater stored on land over millennia into oceans and raise the global mean sea level. Ice sheet freshwater flux alters the status of ocean stratification and ocean-atmosphere heat exchange, inducing oceanic surface cooling and subsurface warming, hence an impact on the global climate. How the climate effects of ice sheet freshwater would feedback to influence the retreat of ice sheets, however, remains unsettled. Here we develop a two-way coupled climate-ice sheet modeling tool to assess the interactions between retreating polar ice sheets and the climate, considering a variety of greenhouse gas emission scenarios and modeled climate sensitivities. Results from coupled ice sheet-climate modeling show that ice sheet-ocean interactions give rise to multi-centennial oscillations in ocean temperatures around Antarctica, which would make it challenging to isolate anthropogenic signals from observational data. Future projections unveil both positive and negative feedbacks associated with freshwater discharge from the Antarctic Ice Sheet, while the net effect is scenario-dependent. The West Antarctic Ice Sheet collapses in high-emission scenarios, but the process is slowed significantly by cooling induced by ice sheet freshwater flux.